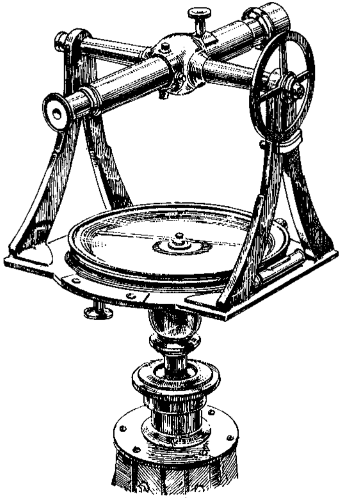
The Work of the District
1866-1971

STEAM AND THE NEW TECHNIQUES

By the time the Philadelphia District came into official being in 1866, two great moving forces in American life were attaining maturity of a distinctly national stamp. One was a school of engineering, forged by a varied roster of military and civil engineers through three wars and the building of a nation. The other was the precipitant development and application of the great mover: steam.

Adapted from European precedents, both sciences in their American forms quickly surpassed their continental models, through characteristically American proliferation. The remarkable number and variety of steamboats plying the waterways of the United States prior to 1820 elicited the amazed comments of visiting European engineers; M. Marestier, of the French Royal Maritime Department, found much to emulate during his survey of United States steamboats[1]. Steamboat traffic on the Delaware River had already achieved an established pattern. Experimentation with high pressures resulted in frequent boiler explosions and attendant loss of life, until the introduction of safety valves and improved methods of boiler construction. The screw propeller, eventually to replace side- and stern-wheel propulsion, already moved Ericsson Line steam packets around the District area in 1844. By mid-century steam tugs pushed and towed huge quantities of every conceivable cargo in Delaware and Chesapeake Bays and their connecting canal. Pile-driving, an infant technique in 1800, could be undertaken in the late Fifties with some assurance of predictable results, thanks to the well-documented experiments of engineers, chiefly military, employing steam-powered drop hammers. Hollow iron screw piles, much favored by engineer Major Hartman Bache, were driven by steam rigs to support typical area lighthouse structures and the famous Iron Pier at Lewes, Delaware.

In 1852, Congress authorized construction of a steam dredge, equipment and discharging scows "for the waters of Chesapeake Bay and the Atlantic Coast." Steam, harnessed to the mud-diggers, gave impetus to the growth of the new and vital dredging industry. Within four decades all the essentials of that industry would be developed, with powerful pumps and cutters, all steam-powered. The Patent Office House Document for 1855 bulged with new specifications; many for steam valves and new types of boiler construction. American inventors proliferated like mushrooms; all seemed intent on mechanizing every phase of life and on hitching the power of steam to every thing mechanical. The opening of anthracite fields, first, and later of bituminous coal mines, supplied the ingredient which vastly extended the application of steam power, accounting significantly for the phenomenal surge in industrial development. Annual coal production in the United States was seven million tons for 1850, 14 million tons



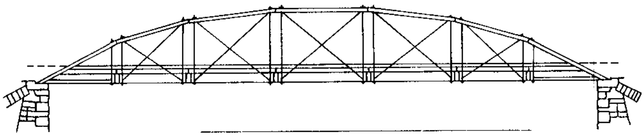
Vernier Transit, 1840

for 1860 and 240 million tons in 1900.

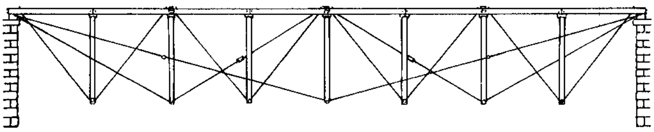
The Sixties saw the beginning of the mechanization of navies, of iron-clad vessels with armored mechanical turrets and steam propulsion. President Grant officiated at ceremonies to inaugurate the services of two great engines in the Seventies; at Friedensville Mine in 1872, the "President's Engine" with its 75-ton twin fly-wheels was the largest pumping engine of its day and a long way from the first mine-unwatering engines of Savery and Newcomen. It was outstripped by the great Corliss, largest steam engine ever built, started up by the President to open the Centennial Exhibition in Philadelphia on 10 May 1876.

"Power" was the theme of the Centennial; and the characterizing aspect of the nineteenth century's growth and development. The new power fostered and supported the geneses of new disciplines — for railroads, a specific geometry of track curves and grades and foundry techniques revolutionized by Bessemer's Cold blast and Nasmythe's geared-tilt ladle. Steel-wire rope formed the nucleus of new bridge concepts, dispensing with cumbersome, stream-cluttering structures, creating soaring spans hung lightly as giant steel cobwebs. An English genius, Maudslay, contributed a life's effort to work out all the basic forms of modern machine tools. His superb automatic-feed slide-rest mitigated the labors of machinists and initiated an era of true precision mechanics.

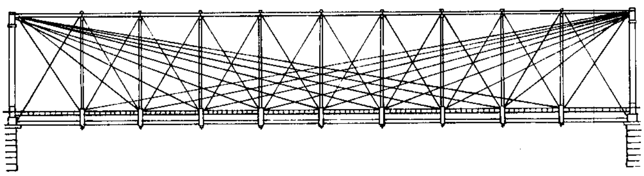
The other power, the emerging American School of Engineering, evolved like the inexorable process toward nuclear fission. The skills which were the virtual exclusive possession of military engineers at the beginning of the nation were expanded and practiced by men of skill and genius in all walks of life. The accumulated knowledge and experience of civil and military engineers were intermingled to the benefit of all phases of the nation's continuing growth: ordnance was designed by civilians (Gatling was a civilian physician), railroads were organized by military engineers (Colonel Stephen Long for the Baltimore and Ohio; General Daniel McCallum for the federalized railroads).



Whipple Bowstring



Fink Deck



Bollman Truss

Wrought iron screw pile construction was typical for lighthouses in Chesapeake and Delaware Bays. This is Windmill Point Light at the mouth of Rappahannock River.

Banked curves for railways were introduced to America by Captain Dennis Mahan, West Point Engineering instructor, whose "Mechanical Philosophy" was a a standard text up to the Civil War years. The renowned Sylvanus Thayer, Superintendent of West Point Military Academy from 1811 to 1833, instituted instructional theories and standards at that institution which would continue to enhance the civil and military engineering professions for many generations. The Military Academy, through its superbly trained graduates, contributed vastly to the establishment of a sound technical base for the engineering endeavors of a legion of pioneer American builders.

Expansion of the railroads brought a need for new bridge designs; improvements in the manufacture of iron shapes, cast and wrought, permitted realization of new concepts for the spans that would support the great weight of locomotives and loaded freight cars. The classic wooden trusses of the intuitive bridge builders were redesigned for iron by a new wave of planners who combined the methods of empirical experimentation with the theories of exact engineering[2]. The Whipple Bowstring, the Fink Deck and the Bollman suspension truss were some of the all-metal designs for timber span replacements on the pioneer railroads in the decade preceding the Civil War.

John Roebling's wire rope replaced hemp rope on the eastern canals to draw boats up the slopes of the portage railroads in the early 1840's. In 1866, Roebling was the world's foremost builder of suspension bridges; his wire rope had been spun into supporting cables for five aqueducts and three bridges of his design and he was within a year of completing a bridge across the Ohio River at Cincinnati, then the world's longest steel suspension bridge. In 1866, James Eads' steel arch bridge, which would span the Mississippi River at St. Louis, was still in the planning stage. But the five-mile tunnel under Hoosac Mountain in Massachusetts was in the twelfth of its 22 construction years; this proving ground for the technology of hard rock tunneling would require the labor of 1,000 men in three shifts around the clock until 1876 and would finally take 195 lives. Among the technological gains were the development, in 1866, of the pneumatic drill and the technique of blasting with nitroglycerine.

In this active, fertile environment the Philadelphia District of the United States Army Corps of Engineers was established. The new entity merely confirmed and more cogently organized the combined endeavors of civil and military engineers in the planning and management of the District area's vital public works program.